

COMMERCIALIZATION OF THE SPACE FRONTIER

William M. Piland
NASA Langley Research Center
Hampton, Virginia 23681-0001

IAF-97-IAA.1.3.01

Presented at the
48th International Astronautical Congress
October 6-10, 1997
Turin, Italy

COMMERCIALIZATION OF THE SPACE FRONTIER

William M. Piland *
NASA Langley Research Center
Hampton, Virginia 23681-0001 USA

ABSTRACT

Past enthusiasm for space programs has been largely driven by our adventurous spirits coupled with the need to compete in the political environment of the cold war. But the cold war is over, the public tends to view space activities as commonplace, the excitement of space is declining, and the current level of public (governments') investment in space activities is at risk. Government funding for space exploration is declining as economic conditions throughout the world force priority decisions to spend scarce resources elsewhere. In fact, some government-sponsored space programs are threatened with extinction. Therefore, if we truly believe space to be the next frontier of the world, it is obvious that something must be done to continue the expansion of that frontier, and somehow assure that space will be available as a resource for future generations.

Perhaps the key to the future of the space frontier lies not only on governments' shoulders, but also on a world business infrastructure that can benefit from expanding terrestrial commerce to the frontier with some help from governments. Some countries already believe that one way to rekindle public support for space exploration is to focus some level of government space investments in areas that will more directly impact the economic environment. Investments in space technologies that stimulate business activity lead to growth in commercial uses of space and a corresponding enhancement of the economy. But even investments in these focused areas are becoming more restricted. At least one solution to this dilemma is to somehow encourage the international business communities to take a more active role in the exploitation of space. Commercial uses of space are growing at a fairly solid rate. However, improvement in international economic conditions and assurance of expansion of the space frontier should occur if the commercial uses of space can be further accelerated, if more non-traditional commercial uses of space can emerge, if businesses can be encouraged to assume more of the risks of ventures into space, and if

businesses will invest larger amounts of capital with expectations of reasonable rates of return. How to provide encouragement by governments for more rapid business investments has been debated without sufficient results.

This paper discusses the current outlook for space business, how growing space business will improve the quality of life for all, and identifies strategies for better relating international space research, technology, and space system operations to commercial interests in space. By drawing on recent assessments of the future potential for business in space, opportunities will be defined for encouraging the growth of business uses of space and regaining the public's awareness and support for expanding the space frontier.

INTRODUCTION

Space activities are inherently global by nature. More than 20 countries have active national programs related to developing space infrastructure with the United States, Europe, Commonwealth of Independent States (CIS), China, and Japan leading the way. However, with national investments in space activities and public interest in space both declining, it would appear that the near-term viability of the planet's space programs is, to some extent, related to their relevance to the future of the world's economy--an area in which all people have considerable interest.

Most government-sponsored space programs have focused on the scientific return on investments in space systems and missions. Few programs have been advocated on the basis that space endeavors can lead to overall improvements in national economics. For example, there is some conscious effort on the part of the Europeans and Japanese to select investments in space activities that will result in economic return. This is not to demean the value of scientific/engineering ventures in space; in fact, the benefits to our society and implications for our quality of life are not easily overstated. It should also be noted

* Director, Independent Program Assessment Office

that other space programs have not completely ignored the potential commercial uses of space. However, from the public's point of view, it might appear that efforts in this regard have been almost secondary to the principal reason for space pursuits: space science and exploration.

The world has changed; the international economy has changed. Financial pressures on government-sponsored space activities are resulting in fewer new programs and finding new ways to cut costs associated with achieving traditional government space objectives. Since most governments are experiencing the same situation, international partnerships are developing to share in the costs of space exploration. These partnerships, created for preservation of space science and exploration (and the continued expansion of the space frontier), may also provide the basis for an international approach to encouraging the commercial investment in space, which, along with governments' investments, can have a more positive effect on the world's economy. Once the public begins to recognize the economic benefit, there should be more positive support for governments' investments in space. With greater public support, perhaps space science and exploration can again return to a level that assures more near-term expansion of the space frontier. In other words, governments individually or jointly should seriously consider future investments in space using economic return as one of the main investment criteria.

One would be perfectly justified in questioning this author on how he might consider himself qualified to comment on the economic matters of the world. Frankly, economic matters on much smaller scales confuse him. However, one only has to read or listen to the news to understand the present public view of government investments in space activities. Common sense would lead one to the conclusion that there is a relationship between exploring space, which is a traditional government role, and exploiting space, which should be more a commercial role with economic implications. What is presented here at a cursory level must be subjected to more in-depth analysis and verification. To those who might share these general views, you are invited to join in the expansion of these ideas. Speak out! After all, we do not want the future of the space frontier to be in jeopardy, nor do we want the world to miss a tremendous opportunity to improve its economic outlook.

THE PUBLIC'S VIEW OF SPACE

One aspect of the current public view of government-supported space programs involves considerable skepticism; skepticism about the ability to

provide the leadership demonstrated in the sixties and seventies. The concerns for the quality and efficiency of space programs' output have been real and, to some extent, justified. The purpose of the present discussion is not to address these concerns in any meaningful way, but it should be noted that considerable, recent effort has been devoted to making government-supported programs much more efficient. Hopefully, in the near future, signs will be visible to the public that governments are diverting from their previously perceived course and again demonstrating solid technical and programmatic leadership.

However, the most critical and damaging view of government-sponsored space programs relates to their purpose. The fact is that a close examination of that purpose and its value to the world is underway at a time when the world's focus is primarily driven by overall economic conditions. All government programs, not just those that relate to space activities, are under scrutiny for need, relevance, size, cost, etc. The acceptance of a continuing level of space investments based primarily on the value of science and exploration is clearly becoming more difficult in the face of painful choices to balance budgets and strengthen economies.

THE VALUE OF THE SPACE FRONTIER

Among other things, the world needs involvement in space and an expansion of the space frontier. There is no doubt that space is important to the planet's future. There has been some downsizing of all space programs, and there will probably be more; "right sizing" is not bad. The United States (National Aeronautics and Space Administration and the Department of Defense), Europe, and more recently Japan have been undergoing downsizing and restructuring, and private companies have been forced to diversify in business areas other than those traditionally government funded. However, the decision on the proper level of investment in government space programs is difficult. Hopefully, political motivation in the downsizing process will be minimized as drastic cuts and program dilution (or wholesale elimination) is not in anyone's best interest. Our society will suffer. What must be included in the investment-sizing process is a reassessment of which programs and activities can better benefit the economy and what initiatives can be implemented for encouraging and helping industry decide to invest in space commerce.

The answer to the question of how much funding is appropriate for space programs may lie in the relationship that can exist between the world's governments and the world's businesses.

Government space programs can have a serious, expanded responsibility for fostering the creation of growth in the business (commercial, industrial, and financial) use of space. This can be looked upon as a charter to serve as the facilitator in evolving an earth-space infrastructure for the conduct of routine, affordable (profitable) business in space. As strange as it may seem, much of world's space programs already encompass the elements needed to fulfill the charter, but we don't describe it that way, and not many people recognize it that way.

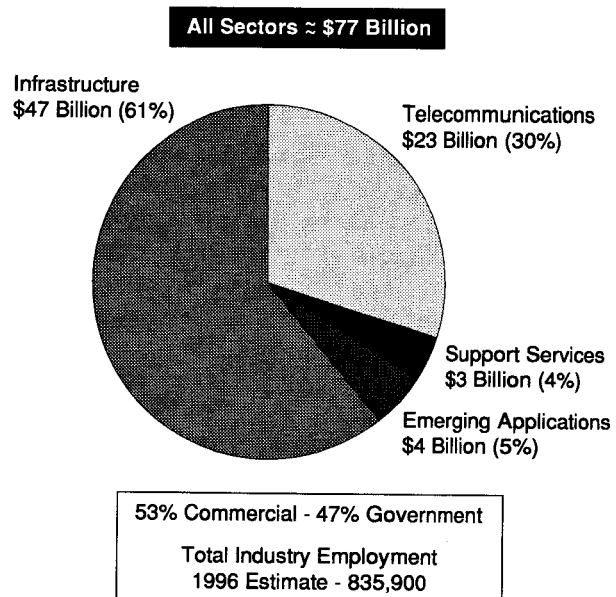
THE POTENTIAL OF SPACE BUSINESS

Commercial space is in its infancy, but it is already very much expanding the breadth of the economic activity of Earth. As a definition of the space industry, Reference 1 offers the following: The space industry consists of those activities which depend on, or relate to, having and using a satellite or assets in orbit, and include, but are not limited to the following:

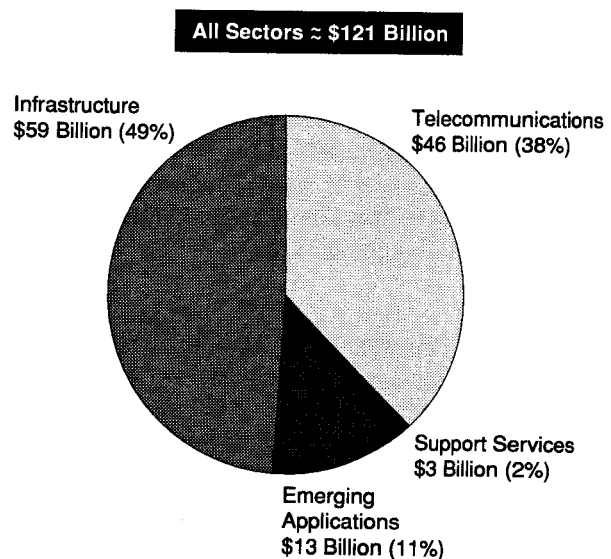
1. Manufacture, test, delivery, launch of satellites, other spacecraft, and related transportation systems.
2. Operation or utilization of satellites or spacecraft outside the Earth's atmosphere.
3. Manufacture and operation of related facilities on Earth.
4. Commercial application to other industries of space technologies, products, and services developed in connection with space.

Recent studies of future space business indicate that great potential exists for growth in the commercial uses of space. One study (Reference 1) published this year on the outlook for future business in space indicates that space commerce is beginning to integrate itself solidly into the global economy, and is here to stay. In fact, it predicts that future growth cannot be stopped. This study states that the space industry is enabling sweeping changes for our homes, workplaces, leisure time, schools, hospitals, and even our dreams. In 1996, worldwide space industry revenues totaled \$77 billion with employment of almost 900,000 people. The space industry is already one of the largest of the world's industries. The industry is expected to grow to a level exceeding \$120 billion by the year 2000. A shift of revenue sources has occurred with 1996 being the first year that commercial revenues have surpassed governments' expenditures (commercial 53 percent and governments' 47 percent). Future growth in commercial revenues is predicted to be at a rate of at least 20 percent per year represented by four space business

areas: infrastructure, telecommunications, emerging applications, and support services. An example of future growth and the relative commercial and government activities is shown in Figures 1 and 2.



*Figure 1. Global 1996 space industry revenues.
(from Reference 1.)*



*Figure 2. Projected 2000 space industry revenues.
(from Reference 1.)*

Infrastructure

Satellites, along with launch vehicles, ground equipment and operation, and associated research and development constitute what the study refers to as "infrastructure." Infrastructure, representing 49 percent of the 1996 space business, is predicted to

grow from a revenue level of \$45 billion to about \$60 billion in the year 2000. As a point of interest, expendable launch vehicle revenues are expected to grow at a compound rate of 40 percent for commercial use while the growth rate for vehicles purchased for government use will be only 2 percent.

Telecommunications

The telecommunications area is the world's fastest growing space-related business. By revenue level, it represents 38 percent of the present space market, and is predicted to grow at a very rapid rate in the future. For example, the mobile telecommunications services market is expected to expand by over 800 percent in the next 4 years. The cellular market is experiencing subscriber growth of 30 to 40 percent per year. By the year 2000, there will be 70 million cellular subscribers in the U.S. as a new subscriber is gained every 2.8 seconds (Reference 1).

Emerging Applications

Presently, the area of emerging applications of space technologies and activities comprise 11 percent of the space market. This segment of the market consists of the sale of remote sensing information, global positioning/locating services, manufacturing in the microgravity environment of space, and many other commercial space-related activities having potential for large revenues. With \$3 billion in revenues currently, the emerging applications area is projected to grow to greater than \$13 billion per year by the year 2000. Actually, many believe the potential growth to be much larger if new space business opportunities come into existence.

As described in Reference 1, remote sensing may be the most significant commercial application of space. Like telecommunications, the remote sensing area could change how many Earth-bound industries operate. Industries including forestry, oil and gas, agriculture, mining, transportation, utilities, environmental monitoring, disaster management, and state and local governments can benefit from the use of information obtained from the vantagepoint of space. Revenue from the remote sensing business is expected to double in the next 4 years.

Global position location from space is a tremendous space business opportunity. The application of Global Positioning Satellite (GPS) capabilities is illustrated by a recent announcement in Japan of the use of GPS technologies to keep track of the elderly who may stray. Using technologies already proven useful for tracking wildlife, paroled criminals, and fleets of

commercial trucks, a pocket transmitter costing less than \$400 will be used to monitor their location. To quote the U.S. Secretary of Transportation, Federico Pena, in 1996, "Today, not many Americans know what GPS is. Five years from now, they won't know how they lived without it."

Because access to the microgravity environment is currently limited and there have not been practical demonstrations of space-made products on a commercially significant scale, there remains a considerable amount of work to prove the payoff of manufacturing in the space environment. However, the promise of purer materials for biomedical and other applications, beneficial medical research, and better thin-film deposition for the development of semiconductor materials gives considerable encouragement for potential growth in this area.

Another study that has received considerable international attention is the Commercial Space Transportation Study (CSTS), Reference 2, conducted during 1993 and 1994 by the CSTS Alliance in which six major U.S. aerospace companies participated. The CSTS and other subsequent space business assessments concluded that a high potential, large moneymaking industry on the horizon is the space tourism business. These studies conclude that 30 to 40 percent of Americans and 50 to 60 percent of the Japanese would pay up to 30 months' salary for a visit to space. A world space tourism business would sell 150,000 tickets a year at \$72,000 a trip and 950,000 tickets at \$12,000 a trip (Reference 3). Considering that most travel industry revenues are attributed to the sale of goods and services in addition to the sale of airline tickets, the potential for revenues resulting from a space tourism business is enormous.

The current terrestrial travel business in the U.S. alone is over \$400 billion per year; 10 percent of these revenues are from the adventure tourism market. Space tourism is certainly considered adventure tourism of the first order. So why would anyone want to take a vacation with the inherent risks of space travel? Tom Rogers of the U.S. Space Transportation Association and an enthusiast of public space travel offers the following point: "Yes, space tourism is hazardous; so is climbing Mount Everest. Last year, eight people died climbing the mountain, and six died this year. As of July of this year, 330 more people were either climbing, or waiting to climb, the mountain with each spending about \$65,000 for the attempt." To add to Mr. Rogers' argument that adventure travel with high risk is real, an article in the August 4, 1997, "Virginian Pilot" newspaper stated 29 people died during the previous 3 weeks while climbing in the French Alps. As of September 15, 1997, that number

has risen to 60. Many people obviously find considerable pleasure in life-risking activity for the sake of adventure, and they can afford it.

Of course, the critical, business-enabling achievement that must be realized is much lower cost space transportation. For the purpose of supporting a space tourism business, some believe the cost of space launch must be lowered to less than \$400 per pound. The vehicle must have very high operational reliability (on the order of 99.9999 percent--based on surveys related to product liability cases) with very high schedule assurance.

During an international symposium held in Bremen, Germany, earlier this year, the mood was that the future of space activities boiled down to two choices: tourism or taxes. Public taxes supporting space activities were quoted (Reference 4) to be on the order of \$25 billion now (probably a low estimate), and the world will not settle for any more, and would certainly like the figure to be much less. Therefore, the notion is that the only good possibility for continuing that level of space investment is possibly through space tourism and the creation of related tax revenues.

As discussed in Reference 2, a potentially very large, new space business is hazardous waste disposal. In the year 2000, there will be more than 50,000 metric tons of high-level nuclear waste in the U.S. to dispose of, and spent reactor fuel is accumulating at a rate of 1,000 tons a year. These wastes will remain radioactive for 10,000 years, and the terrestrial storage is becoming an increasingly complex problem. In spite of considerable study of the problem and the expenditure of great amounts of money, we still do not have a viable terrestrial solution. Without the need for any new technology, it is feasible to dispose of processed nuclear waste in space; a potential new business with huge revenues. In this case, the business-enabling requirement is not only much lower space transportation costs, but also the requirement of public acceptance of the concept. The latter will undoubtedly be the harder of the two to achieve.

Another emerging application of space for business is the generation of space power for terrestrial use. Solar power satellite concepts and associated infrastructure were actively studied in the 1970's and generally found to be too large, too expensive, and had too many technical issues to be seriously considered for development and operation. More recently, the idea of solar power satellites is beginning to resurface with new technology now available, with the promise of lower cost space transportation, and with the more urgent need to find solutions the

growing electrical energy demands without further impacting the world's environment. If a commercially viable concept materializes that will provide a large part of the Earth's energy requirements with solar power beamed from space, the business activity and the revenue from this area could far overshadow all other commercial uses of space.

Spin-off Applications

There is tremendous "spin-off" return on the investments of government and industry in space activities. A 1989 University of Wisconsin study estimated that greater than \$1.5 trillion and 20,000 applications had been added to the U.S. economy alone over the previous 30 years from commercial application of space technology.

An interesting aspect of expanding space business is the possibility that businesses outside the traditional aerospace community can benefit. A case in point is associated with the recent Mars Pathfinder Mission success. The Mattel Toy Company, under license from the Jet Propulsion Laboratory (JPL), produced a toy rover for sale to the general public. Priced at \$5, 1,500 of the toys sold out in 20 minutes at the JPL souvenir store. The JPL is not making a lot of money on this deal, but it is good business for the Mattel Toy Company.

Another example of nontraditional space business activity was described in the August 21, 1997, edition of the "Virginian Pilot" newspaper. It seems that commercial advertising continues to take advantage of space opportunities. A commercial for Israel's Channel Two Television shows Mir cosmonaut Vasily Tsibliyev drinking Tnuva milk. The 90-second commercial, which will only be broadcasted in Israel, cost \$450,000 to produce, and an undisclosed fee was paid to the Russian space agency. One would assume that as space advertising business continues to grow, there is the possibility that civil space programs will gain financially, perhaps in very significant ways.

Support Services

As a relatively small (\$3 billion per year) revenue producing commercial space area, support services includes professional and financial services, space insurance, and publishing. Although this space business area is seen as stable over the next 4 years, one would assume it to be a higher growth area as space commerce expands. For example, engineering, legal, financial, technical support, and business consulting services should be in demand as newly emerging space businesses realize that their activities

can benefit from operations in space. They will require the help of space experts in the above disciplines to help the transition from conducting business on the ground to exploiting the new frontier.

Future Space Business

A good summary of the future potential of space business (both commercial and government funded) is shown in Figure 3.

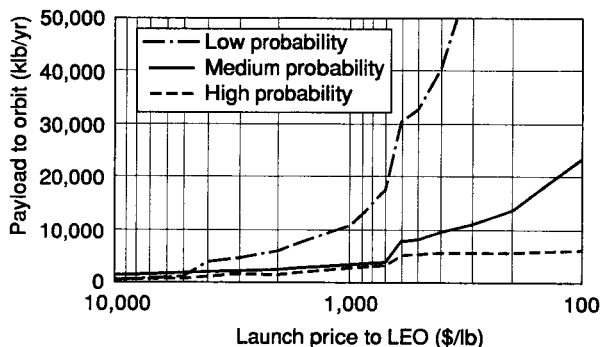


Figure 3. Aggregate launch vehicle market elasticity as a function of reduced costs. (from Reference 2.)

The CSTS data of Figure 3 illustrates that there are high, medium, and low probabilities of the emergence of various space-related markets depending on the cost of transporting goods to orbit. At \$1,000 a pound, about one tenth of the present cost, the space business market, as measured by mass carried to orbit, could double. The Study further concludes that at \$600 a pound, several new markets will emerge, and at \$400 a pound, there will be significant growth in the traditional markets previously discussed. Obviously, much lower space transportation costs remain key to the future growth of space business.

If one were to assume that the volume of space business is directly proportional to the mass which might be transported to space for the conduct of business, then recent studies conservatively estimate that, under certain circumstances, the potential for space business growth is at least one order of magnitude over today's level. Existing commercial users of space will expand their businesses if the cost of doing business in space is substantially reduced. New users (some of which now have only the foggiest notion of how to do it) will expand existing Earth-bound business to space if facilities are available (and affordable) and if those who understand space operations will provide encouragement and engineering/technical support.

The preceding discussion illustrates that business can make money in space. We also know that with the general growth of business, we can expect more jobs and overall economic improvement. The process of improving the world's economic situation is not that simple, but the potential of billions of dollars in increased revenues and hundreds of thousands of new jobs should not be trivial to the economic equation.

Now, there are obviously many events that must take place before private sector uses of space can be expected to expand beyond their present rate and resulting economic benefits are reaped. Among these is for the world's governments to decide what their roles should be in fostering that expansion and in creating the basic space infrastructure elements to accommodate the expansion.

GOVERNMENTS' ROLE

Deciding on the proper role for government in creating and expanding opportunities for the business sector is not an easy subject on which to reach a unified conclusion. It is a heavily debated subject everywhere, and with pressures for governments to spend scarce public revenues elsewhere, we appear a long way from near-term action. The following are some of what many believe to be the fundamental responsibilities of governments in this regard.

Creating a Helpful Policy Environment

Governments' role should include creating a policy environment in which business are encouraged to invest in areas that capitalize on the governments' investments and which reduces or eliminates barriers that deter industry investment. Many current and potential businesses feel that national laws and policies and international trade restrictions are too prohibitive for expansion of space business. For example, in the U.S., although present laws permit the licensing of commercial transport of material to space, they prohibit the licensing to bring it back to Earth. International space-related agreements generally focus on joint science and exploration ventures. Can the world's governments agree on joint approaches to creating an environment for stimulating world business and improving the world's economy? More will be said on this subject later.

Supporting High Risk Research and Development (R&D)

Governments' role might include conducting high-risk R&D that relates to opening new business

opportunities in space. Currently, much, if not most, of the governments' investment in R&D is focused on science and exploration. If business is lucky, some of this investment may provide "spin-off" technologies with which to pursue space business. There may be technologies in which governments can invest to pave the way for business growth in space.

Guaranteeing the Market

To encourage private investment in space activities, governments can serve to guarantee a certain part of commercial markets in areas where governments and emerging space industries both need the same goods and services. The best example of this concept is the recent discussions in the U.S. whereas the government will serve an anchor tenant role for the development and operation of the Reusable Launch Vehicle (RLV).

Providing Incentives

Governments can provide certain incentives to encourage private investment in space (Reference 5). These include:

1. Tax credits on industry investments in space-business-related R&D or manufacturing capabilities, or sales of specific products or services.
2. Forgiveness or delayed payments on space businesses' use charges for government-owned facilities.
3. Transferring ground or space assets to industry for its funding and use without full cost recovery by the government.
4. Providing industries some level of indemnification from space-related liability.
5. Providing some appropriate level of direct government funding of relevant space business activities.

Helping to Create the Space Business Infrastructure

The above discussion was not to suggest that all of a sudden governments have the added responsibility of benefiting society by assuming a new role to improve the world's economy by stimulating space business. In many cases, governments are sponsoring efforts to spawn commercial uses of space, and the economy has felt the payoff of space investments through technology spin-offs and new discoveries and advances that have had great impact. However, in the

context of the preceding discussion, current space programs now have an unprecedented opportunity to better demonstrate their relevance by taking the lead in creating the space business infrastructure.

There may be other elements of this infrastructure, but there are at least three that come to mind. These include space business facilities in which to conduct business, ways to get to and from the space business facilities, and an Earth-bound element for maturing existing and new entrepreneurial space-related businesses to get ready for expanded operations using the first two elements.

A Space Business Park

The infrastructure element involving a facility in space in which to conduct business has been referred to as a Space Business Park (Reference 2). To satisfy the requirements of the many potential users of the park, the exact specifications of the facility need further study. However, some aspects of the facility are obvious. It should be stationed in low Earth orbit, accommodate people conducting various "business" tasks, be safe, provide utilities and work volume adequate for living and working in the space environment, and so forth. Does this facility sound familiar? It should, because the international community has been working to keep its development alive for some time now. It's called the International Space Station.

The International Space Station could (and should) be considered as a model (sort of an X-Plane) for the Space Business Park of the future, and its justification could give greater recognition to the framework being created for cultivating and facilitating the future growth of space business. An emphasis on this aspect of its utilization should have a positive impact on the Space Station's future and the way it is considered by the public. As an added result, stronger advocacy for the program may develop within the international business community, and there may be potential for industry investment in certain aspects of future Space Station development and operation. These investments could serve the purpose of studying and proving the commercial viability of a future Space Business Park. For example, expansion of existing plans for joint government/industry funded, business-related processing experiments aboard the Space Station could be critical to defining the requirements for a future Space Business Park. There may be many other examples. The premise here is that in all elements of the infrastructure, industry buy-in and joint government/industry financial investment could serve to assure overall success of the concept.

There has been considerable discussion of the possibilities for privatization of the Space Station. As an international venture, privatization would be influenced by several factors including:

1. The expected rate of return on the financial investment by industry.
2. Assured propriety of data and data rights
3. Assured access to the facility.
4. Ease of use by commercial ventures.
5. Governments serving as an anchor tenant.
6. Need for government long-term commitment
7. Solving significant issues such as the regulatory environment.

There is much to be done before the International Space Station can be considered for privatization. Not the least is that the development and deployment of the facility must be completed. Then there must be a period of operation during which the facility can be "calibrated" in terms of actual operations cost, etc. Since the Space Station will be an international asset, all owner nations must reach agreement on the terms of privatization and the resolution of the factors listed above; a requirement that may take some time to satisfy. However, as an important step toward the international business community assuming a greater role in the exploitation of space, serious discussions now along these lines can be the catalyst for related dialogue on the overall roles of governments in stimulating expanded business in space.

Getting Business to Space--Affordable Transportation

What if an Earth-bound manufacturing business found that it could benefit from making part of its product in space? The business is not all that large; it grosses \$50 million a year and employs several hundred people. With the part made in space, the company could double its revenue and it would employ twice the number of employees to handle changes in the assembly and distribution process. The manufacturing process the company wants to conduct at the Space Business Park requires the transport of one person to the park four times per year at a total of 2,000 pounds each trip. The price of transporting goods to Earth orbit today runs between \$5,000 and \$10,000 a pound depending on whose data you choose to believe. I believe the correct figure

is probably closer to \$10,000. At \$10,000 per pound, that's \$80 million per year in transportation costs alone. For the time being we'll ignore the rent for use of space in the park. In order to appreciate what these costs mean to this business and whether it can make a profit from this venture into space, many other factors would have to be considered, but the point is that, in this case, the cost of transportation to space is critically significant. Now suppose someone offered the company a ride to the Space Business Park at a price 20-times less. The cost of transportation is reduced to \$4 million per year, and the prospects of making a profit from this venture could be much improved. The CSTS Alliance reported that about a factor of 20 reduction in space transportation price to the user would be sufficient to stimulate a major increase in the commercial activity in space with the result of creating jobs and impacting the economic health of the United States.

So what can be done to lower the cost of getting to and from the Space Business Park and to permit expansion of the business use of space? The world space community has been engaged for some time now in a dialogue about cheaper space transportation, but so far not much has been done. In fact, there have been several programs considered which were to focus in this direction and even a few started. For one reason or another most have dissolved.

There are several current programs in the U.S., such as the Reusable Launch Vehicle (RLV), that represent steps in the right direction. The RLV program, for example, promises to substantially reduce the cost of transportation (although a factor of 20 may be debatable), and it has created the possibility of a new and better way of developing and operating the next generation launch system. This includes the concept of government supporting and industry leading the program, with the major development investment borne by industry. On the other hand, one may be interested in referring to the CSTS report (Reference 2) to form an opinion about the circumstances under which the industry might justify its capital investment in the RLV program. Most agree, however, that the industry/government partnerships in place will prove beneficial and lead to the building and flight test of X-Plane concepts that will substantially reduce the development risks normally associated with programs of this magnitude.

Given that the initial research and development portion of the RLV is now underway, the task at hand is to keep this program and other national and international programs like it from becoming victims of government budget cutting. Although it may be important for the creation of a space business

infrastructure to reassess the specific program goals related to launch cost reduction, it is equally important to see that these programs survive. Consider the strength added to future launch vehicle programs' justification if they are placed into the framework of the space business infrastructure and, along with the Space Station, form the necessary space elements to expand businesses use of space.

Assisting In Space Market Research and Demonstration

Another element of the space business infrastructure (and one of importance equal to that of the other elements) is the part that is carried out on the Earth's surface. The scope of exactly what needs to be done to make sure business is ready for ventures into the space arena is not as clear as with the other two infrastructure elements. However, discussions on the subject of maturing potential space markets suggest at least one other critical step that must be taken--and taken soon. This step involves providing technical support to the potential space users. Many of them need encouragement. Most know little about what space can do for their business or how to operate in that environment. In this regard, there is help. The aerospace industry can do the most by establishing industry partnerships in promising business areas. In addition, governments may help by fostering and enabling these industry partnerships. Much of the governments' expertise and facilities are applicable to the task. In return, the governments' costs of conducting future science and exploration missions will be reduced because of the commercial sector's investment in space and the evolving space business infrastructure. For example, reduced government space transportation costs will result from lower-priced vehicles and operations and an expanded launch rate due to the expanded space business operations.

Urgency of governments and industry beginning to work toward the maturity of space markets relates to the timing of bringing together the complete space business infrastructure. While some countries have started to work on the first two infrastructure elements (maybe without fully recognizing it), we have not done enough to get industry ready to use space. In fact, this author is unaware of any coordinated effort to put in place this critical element.

GOVERNMENT AND INDUSTRY PARTNERSHIP FOR EXPANDING THE SPACE FRONTIER

The intent of this discussion has been to provide a framework for an answer to two questions: How can we

protect current government investments in space with pressures to divert funding to other high-priority programs, and how can we expand the exploitation of the space frontier while improving the economic conditions of the planet? In an international scale, government investments in space have declined and the general public's enthusiasm for space activities has also declined. The exploration of the space frontier has been somewhat curtailed. On the other hand, the commercial exploitation of space is growing. For the first time, commercial space-related expenditures exceed those of governments. Even if nothing is done to restore the governments' level of investment, a steady growth in the commercial exploitation of space seems assured.

What has been suggested here is a vision of the future of the space frontier viewed in a little different perspective. If somehow, the governments' interest in space science and exploration can complement and facilitate the commercial interest in space exploitation (i.e., make money), then all will benefit. If governments can justify a role in helping fulfill the business objectives in space, then subsequent, further expansion of space business will result with a positive impact on the world's economy. As the economy improves and the public becomes more aware of how space is directly improving its quality of life, then it reasonably follows that the public may well regain its enthusiasm for funding the traditional space science and exploration activities. Then governments' programs may be looked upon as a solution to the world's fiscal dilemma instead of being a substantial part of it. If one were to share this vision, one might also agree on some of the initial steps needed for its implementation.

Governments could clarify their role and responsibilities to focus on (and perhaps devote a more resources to) the creation of the space business infrastructure. To a limited extent, this is already being done, but not integrated in the way presented here.

Governments could form partnerships with aerospace and non-aerospace private sectors to encourage them to more aggressively invest in the commercialization of the space frontier. This will not be an easy task--trusting governments to live up to their part of partnerships has typically been a problem, but ways to improve trust could be found. Partnerships could be developed whereby space business interests have the leadership role with governments supporting the business effort with resources of expertise and facilities. Private sectors and governments could jointly set goals and schedules, and steps could be taken to assure governments' follow-through with their part of the bargain. If we were to really believe

in this space business vision and its value to the world's economy, then some things would have to change. For example, multi-year funding of governments' commitments would be most helpful. The industry needs the assurance of multi-year stability in the partnerships developed if the whole idea is to be given a chance for success.

We should proceed with developing space business markets. This could start by organizing an international initiative. By bringing together the right aerospace and non-aerospace industry elements to foster partnerships within the industry, enthusiasm can build for more business in space.

The implementation of these ideas on an international scale will require considerably more thought and discussion. The International Astronautical Federation (IAF) could provide the framework for relevant discussion and future action. As an international body having connections with the world's governments currently exploring space, and as an organization with sincere interest in the future of the space frontier, the IAF may be uniquely situated to organize an initiative to expand business investments in space. When asked about the Federation's planned role in space business, the IAF president, Kurt Doetsch, recently responded as follows (Reference 6): "The IAF wants to pose the question of what the main motivators are that will keep us in space for the long term. These include global motivations such as food, shelter, education, health, transportation, communications, and security. It also includes assessing Earth as a global system on which human activities have such a large impact. People need to know how space development can respond to these concerns."

The specific proposal to which the preceding discussion has led is this: The IAF could assume a leadership role in working with the world's governments and the appropriate industries to help encourage the implementation of the ideas presented here. By the IAF President's own words, the organization has assumed the appropriate charter. As an initial step, the IAF could create an International Space Business Enterprise. The Enterprise could initially start as a committee of knowledgeable, international participants tasked to:

1. Develop an International Space Business Enterprise implementation plan.
2. Define steps for bringing governments and industries together to start a dialogue on their relative roles in developing the space business infrastructure and to strategize meaningful partnerships.

3. Sponsor the development of economic models that relate further expansion of space business activities to quantifiable improvements in the quality of life on Earth.

4. Begin to publicize the economic advantages of space business and governments' related contributions to the required business infrastructure and thereby help to rekindle the public's enthusiasm for space.

There are probably several additional tasks the suggested Enterprise committee could pursue, and the author hopes that as the IAF might develop further ideas on the subject, a more complete definition of the Enterprise objectives will evolve.

SUMMARY

Certainly what is presented here needs debate, and many of the conclusions require more in-depth study and verification. In fact, one might declare the author very naive to think that the economic concerns of the world's governments go sufficiently beyond individual borders to unite governments for the purposes described herein. However, in addition to being an advocate for expanding the space frontier, the author believes the world is getting much smaller as evidenced by governments uniting for many other purposes. The world's economy is important to every person on the planet. If an international effort focused on strengthening the world's economy is of interest, then the world's governments might examine civil space programs as a catalyst; a catalyst for encouraging business investments in space and a catalyst for creating the infrastructure for even more rapid growth of space business. With an initiative of the International Astronautical Federation, governments' interest in space exploration and industry's interest in space exploitation may be integrated in a way that will bring the right industry and government forces together to create a new, broader, and more healthy aspect to the world's economy, and in a way that assures expansion of the space frontier for the benefit of future generations. It is suggested that an IAF International Space Business Enterprise could provide that initiative.

REFERENCES

1. *State of the Space Industry*, Space Vest, KPMG Peat Marwick, Center for Wireless Telecommunications, and Space Publications, 1997.
2. *Commercial Space Transportation Study*, Executive Summary, The CSTS Alliance, April 1994.

3. Sott, William B., "*Studies Claim Space Tourism Feasible*," Aviation Week and Space Technology, April 7, 1997, pp. 58-60.

4. Collins, Patrick, "*The Japanese Rocket Society's Space Tourism Research*." Presented at the International Symposium on Space Tourism, Bremen, Germany, March 20-22, 1997.

5. *Space Commercialization*, Public Policy Committee, AIAA Position Paper, January 1996.

6. Doetsch, Karl, Newsmaker Forum, *Space News*, vol 8, no. 27, July 7-13, 1997, page 22.